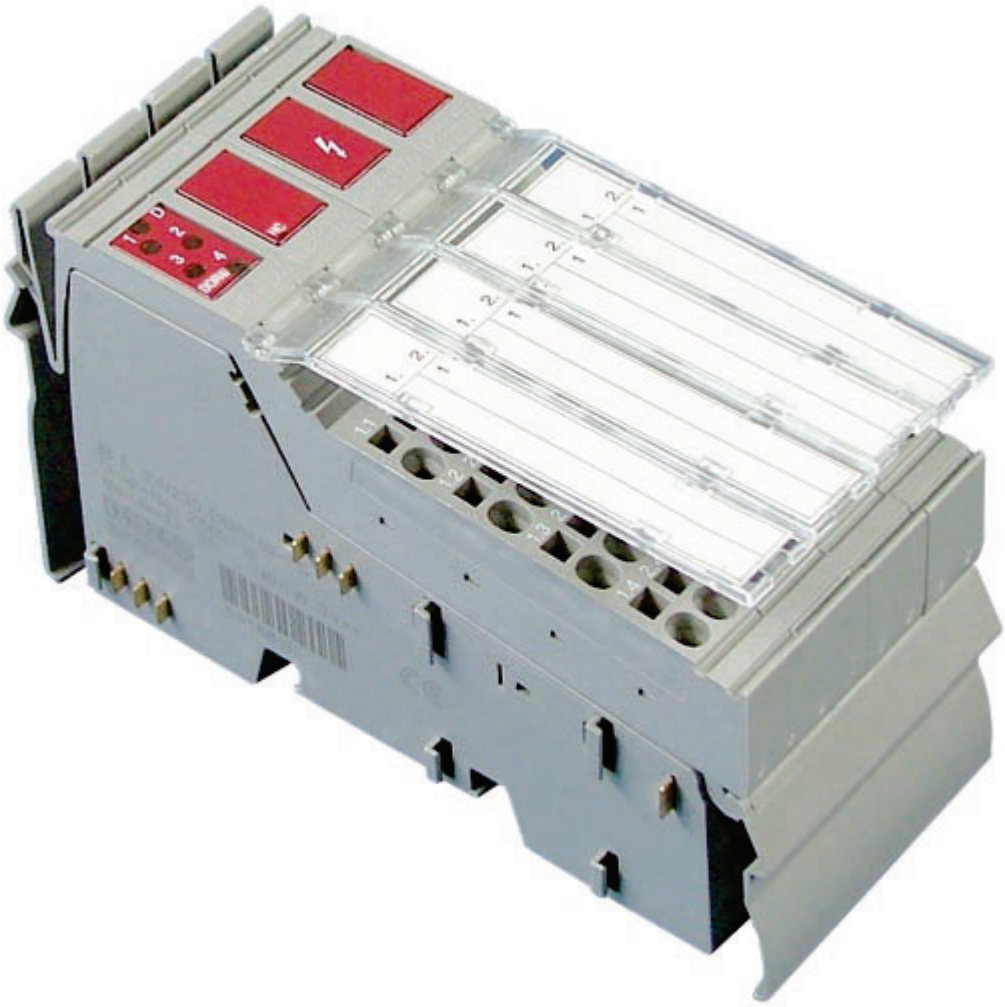
Inline Terminal
ILT 24/230 DOR 4/HC

Device Description



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We are grateful to you for criticism and suggestions. Further information (device description, available software) can be found on our homepage www.sysmik.de. Please ask for latest information.

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Inhalt

1 Overview 4

2 Order Information 4

3 Safety Notes 5

3.1 Safety Notes for Inline Terminals Used in Areas Outside the SELV Area (AC Area) 5

3.2 Correct Usage 5

3.3 Installation Instructions and Notes 5

3.4 Special Features of the Terminal 6

4 Connections 7

4.1 Wiring Guidelines 8

4.2 Terminal Assignment 9

4.3 Typical Terminal Arrangement 9

4.4 Interference Suppression Measures on Inductive Loads/Switching Relays 11

4.4.1 Circuit versions: 12

4.4.2 RC Circuit Versions: 13

4.4.3 Switching Large AC/CD Loads 14

5 Communication 15

5.1 Programming Data / Configuration data 15

5.2 Process Data Structure 15

5.3 Description of Configuration 16

6 Technical Data 17

7 Literature 22

1 Overview

The four channel relay terminal ILT 24/230 DOR 4/HC is designed for use within the modular Inline-I/O system of Phoenix Contact.

Features:

- electrically isolated connections for 4 actuators
- rated current 10 A; at single outputs up to 16 A with derating
- inrush current 30 A, max. inrush current (20 ms) 80 A
- safe isolation according to EN 50178
- low power consumption due to bistable relays
- 3 different operating modes configurable for each output
- communication on local bus via process data
- indicators for diagnostics and status

Modes of operation:

monostable, default state opened (delivery status)

The contact is opened when power supply or bus communication fails. This is the behaviour of a normal make contact.

monostable, default state closed

The contact is closed when power supply or bus communication fails. This behaviour is similar to a break contact, but the control via the process data is not inverted. The command "Set" always closes contact x if bit "relay x" is set - independent of the operation mode.

bistable

The contact holds its current state when power supply or bus communication fails.

2 Order Information

Device	Description	Part number
IB IL 24/230 DOR 4/HC-PAC	Inline terminal with four relay outputs, complete with connectors and labelling fields	1225-100250-04-2
Accessories		
IB IL DOR LV-SET-PAC	Inline distance terminal, complete with connectors and labelling fields, 1 set (2 pieces)	1225-100491-01-8

Table 2.1: Order Information

3 Safety Notes

3.1 Safety Notes for Inline Terminals Used in Areas Outside the SELV Area (AC Area)

Only qualified personnel may work on Inline terminals in the AC area.

Qualified personnel are people who, because of their education, experience and instruction, and their knowledge of relevant standards, regulations, accident prevention, and service conditions, have been authorized by those responsible for the safety of the plant to carry out any required operations, and who are able to recognize and avoid any possible dangers (Definitions of skilled workers according to EN 50110-1:1996).

Note: The instructions given in this data sheet as well as in the user manual IL SYS INST UM E [1] or the Inline system manual for your bus system must be strictly observed during installation and startup.

Technical modifications reserved.

3.2 Correct Usage

The terminal is only to be used within an Inline station as specified in this data sheet as well as the IL SYS INST UM E user manual or the Inline system manual for your bus system. SysMik accepts no liability if the device is used for anything other than its designated use.

Dangerous contact voltage

Please note that there are dangerous voltages when switching circuits that do not meet SELV requirements.

Only remove and insert the AC terminals when the power supply is disconnected.

When working on terminals and wiring, always switch off the supply voltage and ensure it cannot be switched on again.

3.3 Installation Instructions and Notes

Install the system according to the requirements of EN 50178!

Use grounded AC-networks

Inline AC terminals must only be operated in grounded AC networks.

Read the user manual

Observe the installation instructions and notes in the IL SYS INST UM E user manual or the Inline system manual for your bus system, especially the notes on the low voltage area.

3.4 Special Features of the Terminal

The terminal can be used to switch loads up to 230 V.

Note: The terminal interrupts the potential jumpers U_M, U_S, and GND (24 V area) or L and N (120 V / 230 V areas). If required, these supply voltages must be resupplied / provided using an appropriate power terminal after the relay terminal.

Switching loads in the 230 V area

To switch voltages outside the SELV area, an AC area must be created corresponding to the installation instructions and notes provided in the user manual.

Operation on an AC network

Operate the terminal from a single phase on an AC network!

Switching voltages that are not available in the segment

A relay terminal can be used to switch voltages that are not available in the segment in which the terminal is located (e.g., switching 230 V AC within a 24 V DC segment). In this case, place a distance terminal before and after the terminal (see Order Information). The isolating distances between the individual areas are thus maintained.

See also Connection examples in chapter 4.3

4 Connections

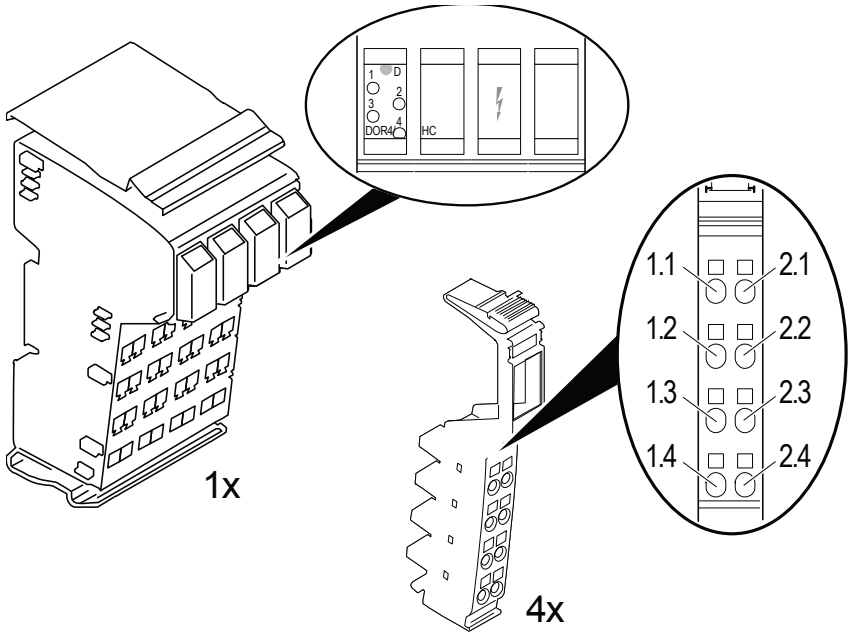


Bild 4.1: Terminal connections

Indicator	Color	Descriptiong
D	green	Bus diagnostics
1, 2, 3, 4	yellow	Status indication of output LED on = contact closed

Table 4.1: Local diagnostic and status indicators

Terminal point	Assignment
1.2, 2.2	common contact
1.3, 2.3, 1.4, 2.4	closing contact

Table 4.2: Terminal assignment

Terminal points not defined in table 4.2 must not be used.

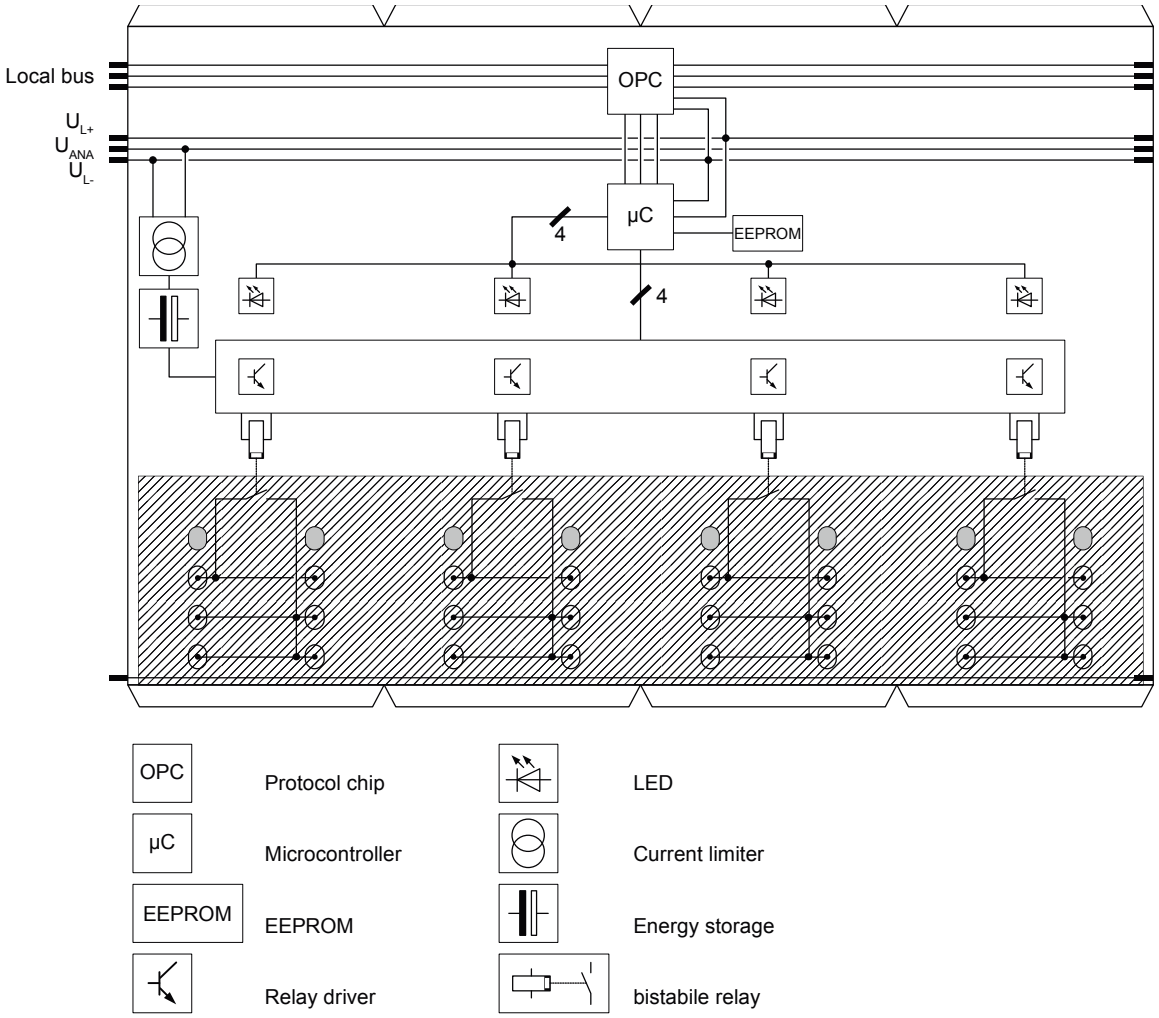


Fig. 4.2: Functional overview

4.1 Wiring Guidelines

For load currents of more than 8 A it is strongly recommended to use 2 wires (2x 1,5 mm^2) in parallel. Single wire connection is allowed too, observing the derating conditions, but the correct connectors have to be used (included in delivery). These connectors are internally connected between terminal points 1.2 and 2.2, 1.3 and 2.3, 1.4 and 2.4.

The load current should be evenly distributed when using two wires in parallel. This means both connections should have the same resistance. The following measures apply:

- equal wire cross-section of 1.5 mm^2 (copper)
- equal wire length
- equal number of additional contact points

Attention: If the internally connected terminal points 1.3, 2.3, 1.4, 2.4 are used as a terminal block, the current of each terminal point must not exceed 8 A.

4.2 Terminal Assignment

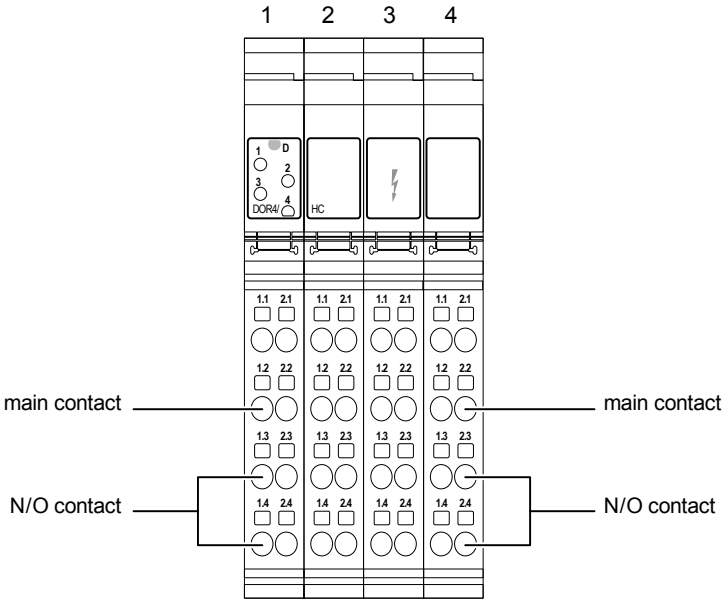


Fig. 4.2.1: Terminal assignment

4.3 Typical Terminal Arrangement

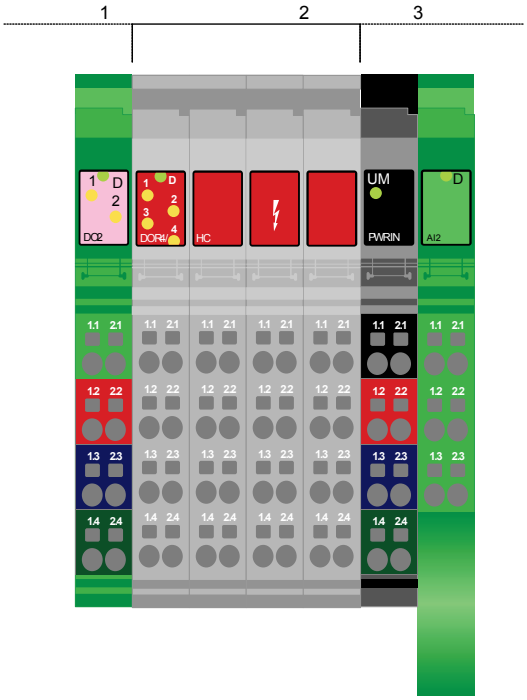


Fig. 4.3.1: Switching 24 V within a 24 V area

1: 24 V area consisting of station head and I/O terminals
2: relay terminal in the 24 V area
3: 24 V area consisting of power terminal and I/O terminals

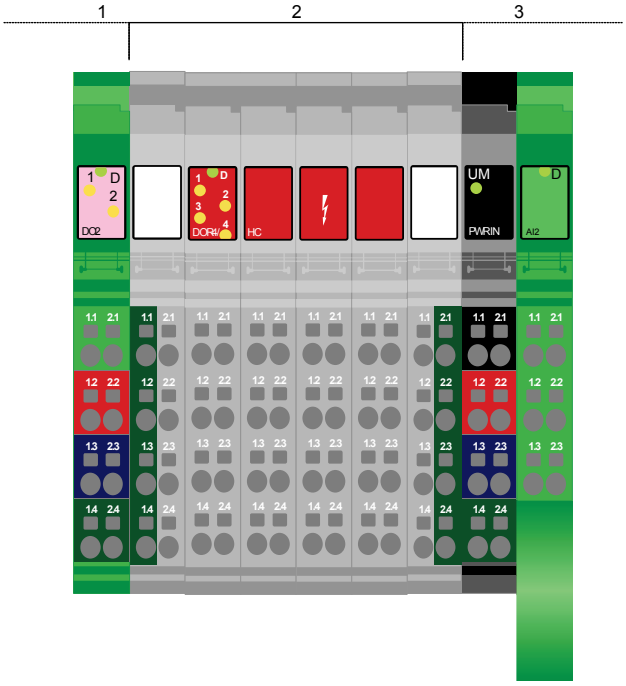


Fig. 4.3.2: Switching 230 V within a 24 V area

1) 24 V area consisting of station head and I/O terminals
2) relay terminal separated from the 24 V area by Inline separation terminals
3) 24 V area consisting of power terminal and I/O terminals

Figures 3.3.1 and 3.3.2 illustrate the two basic types of application: with and without separation terminals. Separation terminals must be used to ensure the required safety clearance between different voltage areas of an Inline station, for example between 230 V AC and 24 V SELV. If the relay terminal shall switch a 230 V load within a 24 V area (or vice versa), separation terminals are necessary. On the other hand, if the relay terminal is used to switch the same voltage as in the adjoining area, no additional separation terminals are needed.

Because the relay terminal interrupts the voltage jumpers U_M, U_S, and GND (in 24 V areas) or L and N (in 120 V or 230 V areas), these voltages have to be re-supplied using an apropriate power terminal after the relay terminal, if required.

Note: On AC networks, operate the terminal from a single phase only. To use several phases, separate areas have to be built using separation terminals - one area for each phase.

4.4 Interference Suppression Measures on Inductive Loads/Switching Relays

Each electrical load is a mix of ohmic, capacitive, and inductive elements. Depending on the proportion of the elements, switching these loads results in a larger or smaller load on the switch contact.

In practice, loads are often used with a large inductive element, such as contactors, solenoid valves, motors, etc. Due to the energy stored in the coils, voltage peaks of up to a few thousand volts may occur when the system is switched off. These high voltages cause an arc on the controlling contact, which may destroy the contact through material vaporization and material migration.

This pulse, which is similar to a square wave pulse, emits electromagnetic pulses over a wide frequency range (spectral elements reaching several MHz) with a large amount of power.

To prevent such arcs from occurring, the contacts/loads must be fitted with protective circuits. In general, the following protective circuits can be used:

- contact protective circuit
- load protective circuit
- combination of both protective circuits

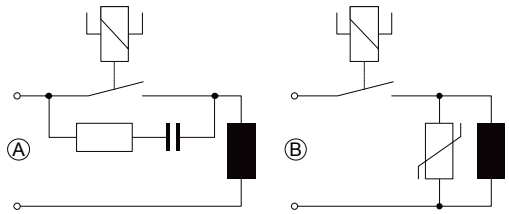


Fig. 4.4.1: Contact protective circuit (A), load protective circuit (B)

If sized correctly, these circuit versions do not differ greatly in their effectiveness. In principle, safety equipment should intervene directly at the source of the interference. The following points speak in favor of a load protective circuit:

- When the contact is open, the load is electrically isolated from the operating voltage.
- It is not possible for the load to be activated or to "stick" due to undesired operating currents, e.g., from RC elements.
- Shutdown voltage peaks cannot be coupled in control lines that run in parallel.

Phoenix Contact provides protective circuit solutions in the form of terminals or electronic housing (see "CLIPLINE" or "TRABTECH" catalogs). Additional information is available on request. In addition to this, today the majority of contactor manufacturers offer diode, RC or varistor elements that can be snapped on. For solenoid valves, connectors with an integrated protective circuit can be used.

4.4.1 Circuit versions

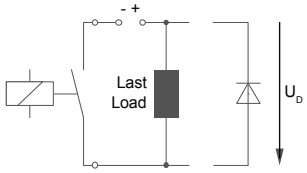
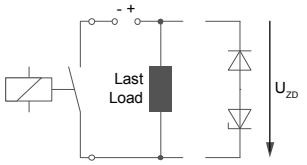
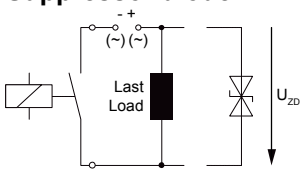
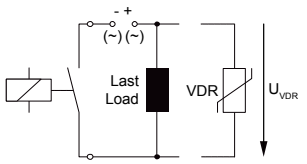
Load wiring	Additional drop delay	Defined inductive voltage limitation	Bipolar attenuation	Advantages / Disadvantages
Diode 	large	yes (U_D)	no	**Advantages:** – easy implementation – cost effective – no critical sizing – small inductive voltage **Disadvantages:** – attenuation only via load resistance – large drop delay
Series connection Diode / Zener diode 	medium to small	yes (U_{ZD})	no	**Advantages:** – no critical sizing **Disadvantages:** – attenuation only above U_{ZD}
Suppressor diode 	medium to small	yes (U_{ZD})	yes	**Advantages:** – cost effective – no critical sizing – limiting fast peaks – suitable for AC voltage **Disadvantages:** – attenuation only above U_{ZD}
Varistor 	medium to small	yes (U_{VDR})	yes	**Advantages:** – high energy absorption – no critical sizing – suitable for AC voltage **Disadvantages:** – attenuation only above U_{VDR}

Table 4.4.1.1: Circuit versions

4.4.2 RC Circuit Versions

RC Series Circuit

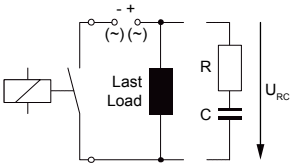
Load wiring	Additional drop delay	Defined inductive voltage limitation	Bipolar attenuation	Advantages / Disadvantages
RC combination 	medium to small	no	yes	**Advantages:** – HF-attenuation due to energy absorption – suitable for AC voltage – level-independent attenuation – compensating reactive current **Disadvantages:** – exact sizing required – high inrush current

Table 4.4.2.1: RC series circuit

Sizing:

- Capacitor: $C \approx L_{Load} / (4 \times R_{Load}^2)$
- Resistor: $R \approx 0.2 \times R_{Load}$

RC Parallel Circuit With Series Diode

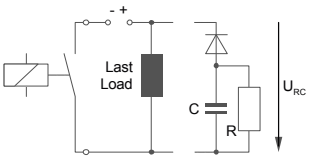
Load wiring	Additional drop delay	Defined inductive voltage limitation	Bipolar attenuation	Advantages / Disadvantages
RC combination with diode 	medium to small	no	no	**Advantages:** – HF-attenuation due to energy absorption – level-independent attenuation – current reversing not possible **Disadvantages:** – exact sizing required – only suitable for DC voltage

Table 4.4.2.2: RC parallel circuit with series diode

Sizing:

Capacitor: $C \approx L_{Load} / (4 \times R_{Load}^2)$

Resistor: $R \approx 0.2 \times R_{Load}$

4.4.3 Switching Large AC/CD Loads

Switching Large AC Loads:

When switching large AC loads, the relay can be operated up to the corresponding maximum values for the switching voltage, current, and power. The arc that occurs during shutdown depends on the current, voltage, and phase relation. This shutdown arc switches off automatically the next time the load current passes through zero.

In applications with an inductive load, an effective protective circuit must be provided, otherwise the service life of the system will be reduced considerably.

To prolong the life of the terminal as much as possible when using lamp loads or capacitive loads, the current peak must not exceed 30 A when the load is switched on.

Switching Large DC Loads

In DC operation, a relay can only switch a relatively low current compared with the maximum permissible alternating current. This maximum DC value is also highly dependent on the voltage and is determined in part by design conditions, such as the contact distance and contact opening speed.

A non-attenuated inductive load further reduces the values for switching currents. The energy stored in the inductance can cause an arc to occur, which forwards the current via the open contacts. Using an effective contact protection circuit, almost the same currents can be switched as for an ohmic load, and the service life of the relay contact is the same.

5 Communication

5.1 Programming Data / Configuration data

Attribute	value
ID code	BF_{hex} (191_{dez})
Length code	81_{hex}
Input address area	1 Byte
Output address area	1 Byte
Parameter channel (PCP)	0 Byte
Register length (bus)	1 Byte

Table 5.1.1: INTERBUS programming data / configuration data

5.2 Process Data Structure

Output-process data byte							
7	6	5	4	3	2	1	0
0	command			relay 4	relay 3	relay 2	relay 1

Table 5.2.1: Structure of output process data byte

Bit			Command	Description
6	5	4		
0	0	0	set	set relays: 0 = opened, 1 = closed
0	0	1	read back	read back current logical relay state
0	1	0	configuration 1 (relay mode)	relay mode: 0 = monostable, 1 = bistable, must be followed by configuration 2
0	1	1	configuration 2 (default state)	default state: 0 = opened, 1 = closed, only effective for relays in monostable mode, has to be sent after configuration 1
1	0	0	configuration 3 (refresh)	refresh of all relays, coded in bit 0: bit 0 = 0 refresh off bit 0 = 1 refresh every 120s bits 1-3 are reserved and must be 0
1	0	1	reserved	
1	1	0		
1	1	1		

Table 5.2.2: Command field in output process data byte

Input process data byte							
7	6	5	4	3	2	1	0
error	command			relay 4	relay 3	relay 2	relay 1

Table 5.2.3: Structure of input process data byte

The input process data byte mirrors the output byte except bit 7, which indicates an error when set.

Command	Error cause
Set	insufficient power supply for switching
Configuration 2	command configuration 1 must be sent first
Configuration 3	invalid parameter (bits 1-3 not 0)

Table 5.2.4: Possible error causes

5.3 Description of Configuration

Configuration example

The terminal shall be configured as follows:

- relay 1: monostable, default state opened
- relay 2: monostable, default state closed
- relays 3, 4: bistable
- refresh: off

Step	Process data	Explanation
1	OUT = $2C_{hex}$	configuration 1 (relay mode): relays 3 and 4 bistable
2	wait for IN = $2C_{hex}$	wait for confirmation
3	OUT = 32_{hex}	configuration 2 (default state): relay 2 closed
4	wait for IN = 32_{hex}	wait for confirmation
5	OUT = 40_{hex}	configuration 3: refresh off
6	wait for IN = 40_{hex}	wait for confirmation

Table 5.3.1: Example of configuration sequence

The relay terminal saves the configuration in a nonvolatile memory (EEPROM). It is therefore not necessary to configure the terminal anew following a loss of power supply or a bus reset.

The configuration is written to EEPROM when the power supply starts to fail, and only if the configuration data has actually changed. Even multiple configuration changes do not lead to an EEPROM write cycle as long as the supply voltage is stable.

Note: Each EEPROM cell has an endurance of at least 100,000 write cycles. This is approximately equivalent to 13 write cycles daily over a period of 20 years.

Note: If there are relays in bistable mode, their switching state is also written to EEPROM when the power supply fails - provided that the current state is different from the previously saved one.

6 Technical Data

General data		
Housing dimensions (width x height x depth)		48.8 mm x 120 mm x 71.5 mm (1.921 in. x 4.724 in. x 2.815 in.)
Weight	with connectors	230 g
	without connectors	167 g
Operating mode		process data operation with 1 byte
Permissible temperature	operation	-10 °C to +55 °C (14 °F to +131 °F)
	storage / transport	-25 °C to +85 °C (-13 °F to +185 °F)
Permissible humidity		75 % on average, 85 % occasionally (non condensing)
Permissible air pressure	operation	80 kPa to 106 kPa (up to 2000 m / 6562 ft.above sea level)
	storage / transport	70 kPa to 106 kPa (up to 3000 m / 9843 ft. above sea level)
Degree of protection		IP20 according to IEC 60529
Inline connector		
Connection type		spring-clamp
Rated cross section		0.2 mm^2 to 1.5 mm^2, AWG 24-16
Insulation stripping length		8 mm

Deviation from Inline specification	
Permissible lowest operation temperature	-10 °C (14 °F)
Mechanical requirements	
Vibration test sinusoidal vibrations according to IEC 60068-2-6; EN 60068-2-6	2g load, 2 h for each space direction
Shock test according to IEC 60068-2-27; EN 60068-2-27	2g load over 11 ms, half sinusoidal wave, three shocks in each space direction and orientation

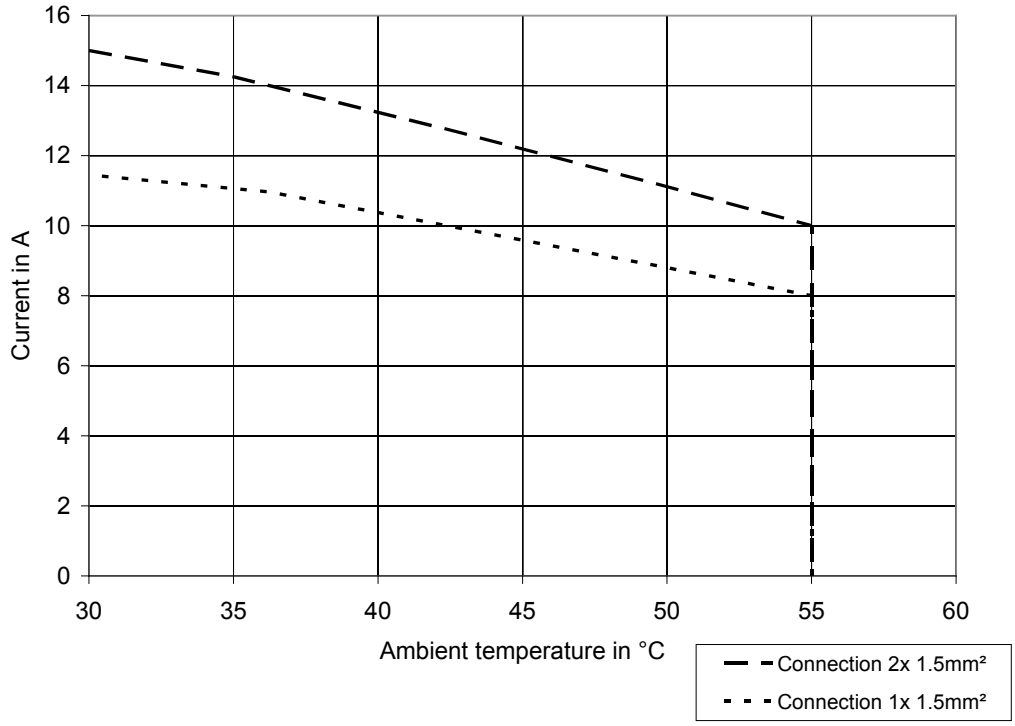
Interfaces	
INTERBUS local bus	
Connection	through data routing
Transmission speed	500 kBaud

Power consumption		
Communications power U_L		7.5 V
Current consumption at U_L	relays off	23 mA
	relays on	34 mA
Power consumption at U_L	relays off	0.17 W
	relays on	0.26 W
I/O supply voltage U_{ANA}		24 V DC
Current consumption at U_{ANA}		10 mA, max. 55 mA when switching (duration approx. 25 ms per switched relay)
Power consumption at U_{ANA}		max. 0.46 W

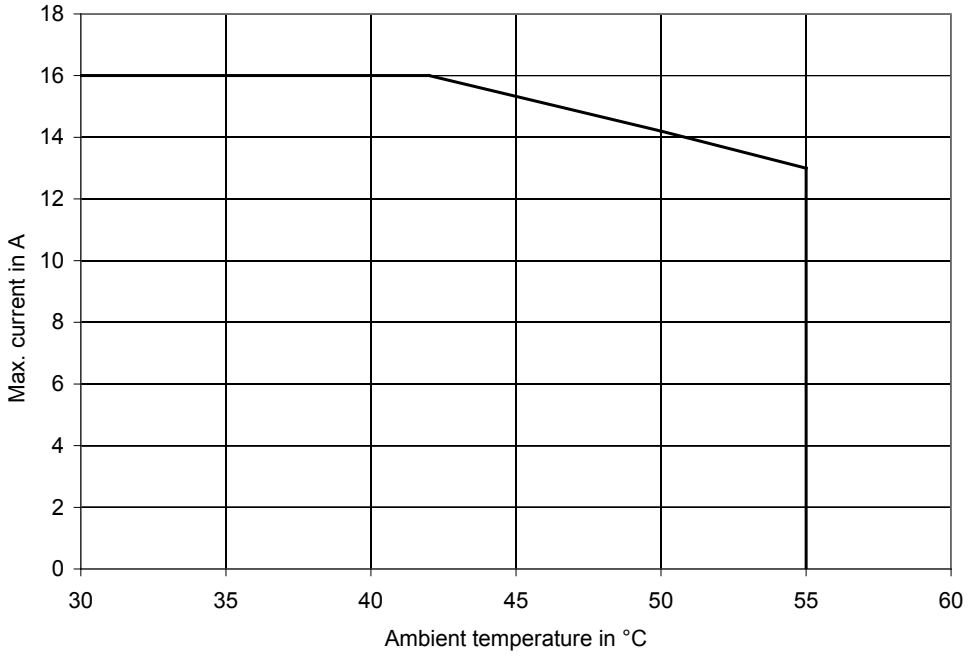
Supply of the module electronics through the bus coupler/power terminal	
Connection method	potential routing

Relay output		
Number		4
Contact material		$AgSnO_2$
Limiting continuous current (at maximum ambient temperature)		8 A single wire connection (1.5 mm^2), 10 A double wire connection (2x 1.5 mm^2)
Maximum switching voltage		253 V AC, 250 V DC
Maximum switchin power		4000 VA
Minimum load		12 V; 100 mA
Peak inrush current (20 ms)		80 A
Max. switching frequency	without load	60 cycles/minute
	at nominal load	6 cycles/minute
Bounce time		typ. 2 ms
Operate- / release time		typ. 5 ms / 4 ms
Common potentials		all contacts electrically isolated
Mechanical life		typ. 30 * 10^6 cycles
Examples of electrical life		
Small load 24 V DC, 100 mA		> 10^7 cycles
Ohmic load, 250 V AC, 16 A		typ. 100,000 cycles
Incandescant lamp 1150 W, 230 V AC, 5 A, (I_{on} = 75 A)		> 20,000 cycles
Incandescent lamp 1000 W, 250 V AC, 4 A		typ. 80,000 cycles
Incandescant lamps 250 V AC, 5 x 60 W		typ. 500,000 cycles
Fluorescent lamps not or serial compensated 14 x 58 W		typ. 50,000 cycles
Fluorescent lamps duo circuit 7 x (2 x 58 W)		typ. 50,000 cycles
Fluorescent lamps parallel compensated (7 µF) 1 x (2 x 58 W)		typ. 50,000 cycles
Energy saving lamps with conventional ballast 40 x 25 W		typ. 40,000 cycles
Energy saving lamps with electronic ballast 3 x 18 W		typ. 40,000 cycles
Electrical motor 250 V AC, 16 A, cos φ = 0.6		typ. 85,000 cycles
compressor, 230 V AC, I_{on_peak} ≤ 21 A, I_{off} = 3,5 A, cos φ = 0.5		typ. 230,000 cycles

Maximum switching current depending on temperature, all outputs simultaneous and with equal currents



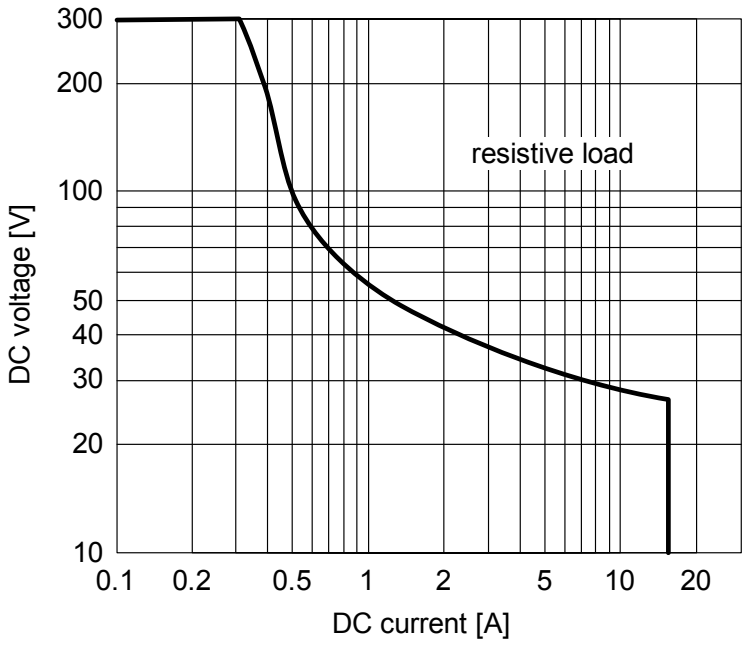
Maximum switching current of a single output depending on temperature



In case of unsymmetric loads, a higher current is acceptable on single outputs.
The following conditions have to be fulfilled:
double wire connection 2x 1,5 mm^2 in case of currents > 8 A
the maximum current must not exceed the value from the diagram above

the load currents of the separate outputs have to fulfill the condition
$I_{L1}^2 + I_{L2}^2 + I_{L3}^2 + I_{L4}^2 \leq 400\ A^2$
Example:
What max. current is acceptable at 50 °C and what current is allowed at the other three outputs?
The diagram shows an allowed load current of max. 14 A. This leaves for the other outputs:
$400\ A^2 - (14\ A)^2 = 400\ A^2 - 196\ A^2 = 204\ A^2$
Therefore, even a second output could be loaded with 14 A and the other two otputs with 2 A each:
$(14\ A)^2 + (2\ A)^2 + (2\ A)^2 = 196\ A^2 + 4\ A^2 + 4\ A^2 = 204\ A^2$
Alternatively, in case of equal load on the remaining three outputs, these could each carry a maximum current of:
$\sqrt{(204\ A^2 / 3)} = \sqrt{(68\ A^2)} \approx 8.2\ A$

Max. DC load breaking capacity
In case of DC loads, the max. DC load breaking capacity may further limit the max. allowed current.



Power dissipation
Equation to calculate the power dissipation in the terminal $P_{EL} = P_{BUS} + P_{REL} + P_L$ P_{BUS} = 0.5 W P_{REL} = 66 mWs x ($f_1 + f_2 + f_3 + f_4$) $P_L = (I_{L1}^2 \times D_1 + I_{L2}^2 \times D_2 + I_{L3}^2 \times D_3 + I_{L4}^2 \times D_4) \times 0.006\ \Omega$ Where P_{EL} total power dissipation of the terminal P_{BUS} power dissipation through bus operation P_{REL} power dissipation through switching relays P_L power dissipation through the load current via the contacts f_n switching frequency (cycles per time) of output n I_{Ln} load current of output n D_n duty ratio of load current on output n: $D_n = t_{on} \times f_n$

Safety devices
None

Error messages to higher-level control system
Peripheral error in case of I/O supply voltage (U_{ANA}) failure

Air and creepage distances (according to EN 50178, VDE 0109, VDE 0110)			
Isolating distance	**Air distance**	**Creepage distance**	**Test voltage**
Relay contact / bus logic	≥ 5.5 mm (0.217 in.)	≥ 5.5 mm (0.217 in.)	4 kV, 50 Hz, 1 min
Contact / contact	≥ 3.1 mm (0.122 in.)	≥ 3.1 mm (0.122 in.)	1 kV, 50 Hz, 1 min
Contact / PE	≥ 3.1 mm (0.122 in.)	≥ 3.1 mm (0.122 in.)	1 kV, 50 Hz, 1 min

Table 6.1: Technical data

7 Literature

[1] User manual IL SYS INST UM E: "Automation Terminals of the Inline Product Range", Phoenix Contact
Phoenix Contact order no. 2698737

[2] User manual IB IL SYS PRO UM: "Configuring and Installing the INTERBUS Inline Product range", Phoenix Contact,
Phoenix Contact order no. 2743048

[3] www.phoenixcontact.com

[4] www.sysmik.de